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*ASTRONOMY IN THE FIRST HALF OF THE  
NINETEENTH CENTURY.*

DURING the first half of the present century the most eminent astronomers, Karl Friedrich Gauss, Friedrich Wilhelm Bessel and Friedrich Georg Wilhelm Struve, were natives of Germany. Gauss was born in 1777 at Braunschweig; Bessel in 1784; Struve in 1793 at Altona. All three were also mathematicians, but of various mathematical ability; in Struve's case his reputation in the higher mathematics was subordinate to that as an astronomer. Gauss was one of the first mathematicians of his age, and perhaps of any time. Bessel was celebrated by his success in the most difficult problems of mathematical astronomy, as well as in the practical handling of instruments, and as a teacher of the science.

Gauss's early ability as a calculator was enough to render him conspicuous in the circle of his friends, and to stimulate his relatives, people of humble station, to make every exertion for his education. He received the degree of doctor of philosophy at Göttingen at an early age, and became professor of astronomy there. His earliest mathematical work was the '*Disquisitiones Arithmeticae*,' in which he inserted the brilliant discovery that a regular polygon of seventeen sides can be inscribed in the circle by ruler and compasses without the use of any means but those allowed by Euclid. When still a young man of twenty-four, he became widely known as an astronomer, by the rediscovery of the small planet Ceres. This had been discovered by Piazzi, and observed only a short time. After this time it was lost in the rays of the sun, and no other astronomer was able to calculate its position with sufficient accuracy to find it again, as proper formulæ were wanting in the astronomical periodicals. These formulæ Gauss possessed, and they solved the problem, and the asteroid was readily found by the re-

sults of his calculations as a star barely visible to the naked eye. As professor at Göttingen, he lived to a venerable age. Among his students was our eminent countryman, Dr. B. A. Gould. Gauss fitted up the observatory with the best instruments of the time, and his works have not yet been published in full sufficiently to content his surviving disciples.

Bessel, seven years younger, was born at Minden; and his early education was in the counting house of Messrs. Kulenkamp at Bremen. He soon found astronomy more interesting than business and became well known amongst specialists in that science. In 1814, he was made a professor and director of the observatory in the rising university of Königsberg, which soon became celebrated as the place where Bessel lived. Every effort was made to keep the young institution at the height of astronomy as then known. He lived there till 1846, when he passed away at the premature age of sixty-two, after many striking achievements, among which is especially conspicuous the first satisfactory measure of a star's distance from the solar system. He showed that 61 Cygni was more than five hundred thousand times\* the sun's distance, or between forty and fifty millions of millions of miles from us.

Gauss lived till 1855 and died at the venerable age of seventy-eight, 'full of age and honors.' His younger friend, W. Struve, was the son of the head master at Altona, whose special department was philology. He received his early training in astronomy at Dorpat, where his ability as a calculator attracted the attention of Huth, then professor there of mathematics and astronomy. Huth allowed him to use the observatory freely. He received his first instructions in the use of instruments from the '*Observator*' Paucker. After

\* In treating this star I have used later figures than those of Bessel.

Paucker went to the college at Mitau, Struve obtained the degree of doctor of philosophy there and was soon made 'Observer' at Dorpat, where he remained a quarter of a century as professor. During his professorship at Dorpat he prepared lectures on the transit instrument, which were translated into French by a pupil, Lieut. Schyanoff, and are still an admirable textbook. Struve's ability attracted the attention of Tsar Nicholas I., and in obedience to his orders, Struve built and furnished the great central observatory at Pulkova, a suburban village near St. Petersburg. For the instruments he consulted the best mechanics in Europe, especially the firm of Repsold of Hamburg. The observations at Pulkova were of the highest possible accuracy and were continued till Struve himself had retired from active service and had been succeeded by his son, Otto Struve, one of his most faithful students and an admirable observer. He died in 1864, and left the reputation of a scientific man, who had accomplished great results for the geography of his adopted country, and was one of the most practical astronomers of the present century.

George Biddell Airy, born in 1801, and surviving till 1892, was chiefly remarkable for the business-like routine which he introduced into the royal observatory at Greenwich, and for the example which was then set to less able astronomers of the manner in which they might conduct extensive operations connected with the vast study of the universe.

The writer considers himself not mistaken in assigning the position of astronomical science during the first half of the nineteenth century to the four philosophers mentioned in this brief paper, viz.: Gauss, Bessel, W. Struve and Airy.

TRUMAN HENRY SAFFORD.

WILLIAMS COLLEGE.

#### THE ELECTRIC FISH OF THE NILE.\*

THE lecture dealt almost exclusively with the formidable fish found in the rivers of North and West Africa, *Malapterurus electricus*.

Photographs were shown of the drawings upon the interior of the tomb of Ti, showing that the fish was recognized as remarkable by the Egyptians five thousand years before the Christian era. Living specimens of the fish were also displayed, these having been given to the lecturer, for the purpose of illustrating the lecture, by the authorities of the Liverpool Corporation Museum.

The structure of the electrical organ was then described. It is situated in the skin enclosing the whole body of the fish, and has a beautiful and characteristic appearance when seen in microscopic sections. Each organ consists of rows of compartments, and each compartment has slung athwart it a peculiar protoplasmic disc shaped like a peltate leaf, with a projecting stalk on its caudal side. Nerves enter each compartment, and end, according to the recent work of Ballowitz, in the stalk of each disc. By these nerves nervous impulses can reach the organ; the arrival of such impulses at the nerve terminations evokes a state of activity which is associated with the development of electromotive charges of considerable intensity constituting the organ shock. The shock is an intense current traversing the whole organ from head to tail and returning through the surroundings; it stuns small fish in the neighborhood and can be felt by man when the hand is placed near the fish, as a smart shock reaching up the arms to the shoulders.

Recent investigations made by the lecturer at Oxford in conjunction with Mr. G. J. Burch were next described. These comprised a large series of photographic records of the displacement of the mercury of a

\* Abstract of a lecture before the Royal Institution of Great Britain.